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| **EBNA IgG (Epstein Barr Virus Nuclear Antigen)** |
| **Purpose** | This procedure provides instructions for performing EBNA IgG (Epstein Barr Virus Nuclear Antigen) on the DIASORIN LIAISON XL. |
| **Policy Statements** | This procedure applies to all laboratory technical staff responsible for performing EBNA IgG testing on the DiaSorin Liaison XL. |
| **Principle** | The LIAISON® EBNA IgG assay uses chemiluminescent immunoassay (CLIA) technology on the LIAISON XL® Analyzer for the qualitative determination of specific IgG antibodies to Epstein-Barr virus (EBV) nuclear antigen synthetic peptide (EBNA-1) in human serum. When performed in conjunction with other EBV markers, this assay can be used as an aid in the clinical laboratory diagnosis of Epstein-Barr Viral Syndrome in patients with signs and symptoms of EBV infection such as infectious mononucleosis.The method for qualitative determination of specific IgG to EBV nuclear antigen (EBNA) is an indirect chemiluminescence immunoassay (CLIA). All assay steps (with the exception of magnetic particle resuspension) and incubations are performed by the LIAISON XL® Analyzer. The principal components of the test are magnetic particles (solid phase) coated with EBNA-1 synthetic peptide and a conjugate of mouse monoclonal antibody to human IgG linked to an isoluminol derivative (isoluminol-antibody conjugate). During the first incubation, EBNA IgG antibodies present in calibrators, samples or controls bind to the solid phase. During the second incubation, the antibody conjugate reacts with EBNA IgG antibodies that are already bound to the solid phase. After each incubation, unbound material is removed with a wash cycle. Subsequently, the starter reagents are added and a flash chemiluminescence reaction is induced. The light signal, and hence the amount of isoluminol-antibody conjugate, is measured by a photomultiplier as relative light units (RLU) and is indicative of the presence of EBV EBNA IgG antibodies present in calibrators, samples or controls. |
| **Clinical Significance** | Epstein-Barr virus (EBV) is responsible for infectious mononucleosis (IM) and is implicated in Burkitt's lymphoma and nasopharyngeal carcinoma. Diagnosis of IM is based upon clinical manifestations that generally include sore throat, fever, lymphadenopathy, and malaise in conjunction with hematological evidence for lymphocytosis and serological evidence for the presence of heterophile antibody and/or EBV antibodies to specific proteins. Clinical manifestations similar to IM can also be induced by a number of other pathogenic infectious agents including Cytomegalovirus, *Toxoplasma gondii*, Hepatitis viruses, Human Immunodeficiency Virus (HIV), and others. The term mononucleosis syndrome is often applied until the specific etiologic agent is identified. Confirmation of an acute diagnosis of EBV IM is generally sought by a positive heterophile antibody test (agglutination by patient's serum with horse or sheep red blood cells). However, difficulties in diagnosis arise when the heterophile test is negative or when clinical manifestations are atypical. Heterophile-negative IM has been demonstrated in 10 to 20% of adults with an even greater percentage in children with acute IM infections. For these individuals, IM diagnosis may be confirmed by identification of antibodies to specific EBV protein antigens which include Viral Capsid Antigen (VCA) and Early Antigen Diffuse [EA(D)]. The presence of VCA IgM antibody usually suffices for diagnosis of IM. However, verification should be sought with additional clinically relevant information (4). Serologic testing for EBV infection is possible because characteristic time-dependent antibody responses occur. Most (> 80%) symptomatic IM patients show near-peak antibody levels of VCA IgG and IgM when first examined. VCA IgM antibodies usually disappear in 2-3 months while IgG antibodies persist indefinitely. Most patients transiently develop antibodies to EA(D), but IgG antibodies against Epstein-Barr Nuclear Antigen (EBNA) appear several weeks or months after the onset of disease and persist for years or even life. In symptomatic IM patients, detection of IgG antibodies to EBNA, when detected in concert with VCA IgM and IgG antibodies, is useful in discerning early convalescent stages from acute stages of IM infection. A rise in EBNA IgG level in IM patients may be indicative of progression from early to later stages of convalescence. The presence of EBNA IgG antibodies in healthy individuals indicates past immunological exposure to EBV. Because of the complex relationship that exists between the EBV virus/host reaction and clinical manifestation, tracking of EBV antibody patterns may assist in diagnosis of EBV infection. Individual levels of specific antibodies are not necessarily indicative of disease state but can be of diagnostic significance when tracked as an antibody response profile. Antibody response profiles for the different EBV antigens demonstrate a characteristic pattern for silent primary or persistent latent EBV infections, as well as for each of the EBV-associated diseases. |
| **Instrument** | DiaSorin LIAISON® XLSunquest Method Code: **XL** |
| **Sunquest Test Code** | **EBVS:** Epstein Barr antibody serology |
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| **Materials** | **Reagents** | **Supplies** | **Equipment** |
|  | LIAISON® EBNA IgG (310520) Integral, supplied ready to use, containing magnetic particles, calibrators, diluent and conjugate. | Glass or polypropylene sample tubes | DiaSorin Liaison XL System |
| **Reagent Integral Preparation** | **How to prepare and load new reagent integrals**1. Remove from refrigerated storage, maintaining upright orientation
2. Inspect integral for leakage.
3. Mix magnetic particle for 30 seconds.
4. Seat test integral in Xcelerator for 30 seconds.
5. Gently rotate the magnetic particle vial for 30 seconds.
6. Remove new integral sealing flaps slowly.
7. Remove all liquid from the surfaces of the membranes to prevent cross-contamination of the reagent vials by blotting using a kim wipe folded in half lengthwise.
8. Open the reagent bay on the analyzer.
9. Using a smooth motion, insert the integral into an unoccupied lane in the reagent area until it rests firmly against the docking pins at the rear.

**Note:** if more than one integral of the same reagent is loaded place the newest integral to the right of the old integral. The analyzer will sample from the left integral until empty, then move right. |
|  | Reagent Integral Storage and Stability:Upon receipt, the reagent integral must be stored in an upright position to facilitate resuspension of magnetic particles. Stored sealed, the reagents are stable at 2-8°C up to the expiration date. After removing the seals, the reagent integral is stable for eight weeks when stored at 2-8°C or on board the LIAISON XL® Analyzer. Record new expiration date on the integral.Do not freeze. The reagent integral must not be used past the expiration date indicated on the kit and reagent integral labels.  |
| **Sample** | Serum is the only acceptable specimen for this assay collected aseptically by venipuncture. Refer to specimen collection procedures.Grossly hemolyzed, lipemic, or particulate samples are not recommendedPrefer Draw Volume: 3.0 mL Minimum Sample Volume: 0.6 mLMinimum Draw Volume: 1.8 mLStability: 2-8 °C / 2 days, 30 days at -20 ºC or colder. Do not store in self-defrosting freezer. Avoid repeated freeze thaw cycles.Rejection criteria: Unlabeled tube, grossly hemolyzed samplesPreparation:Whole blood specimens should be centrifuged as soon as clotted, according to Specimen Processing procedures, prior to analysis. See Processing Procedure Manual.Clarify samples having particulate matter, turbidity, lipemia, or erythrocyte debrisRemove air bubbles before testingTransfer serum to a properly labeled tube. Minimum labeling includes sample accession ID, and/ or patient name, medical record number, collection date and time.If samples are stored frozen, mix thawed samples well before testing. |
| **Special Safety Precautions** | All samples, biological reagents and materials used in the assay must be considered potentially able to transmit infectious agents.Specimens should be handled at the BSL 2 level recommended for any potentially infectious human serum or blood specimen.Avoid direct contact with all potentially infectious materials by using protective clothing such as lab coats, protective glasses and disposable gloves. Wash hands at the end of each assay.Some reagents contain sodium azide as a preservative. Flush drains thoroughly with water after disposal.Disposable materials must be incinerated; liquid waste must be decontaminated with sodium hypochlorite at a final concentration of 5% for at least half an hour. Any materials to be reused must be autoclaved using an *overkill* approach. |
| **Calibration** | Test of assay specific calibrators allows the detected relative light unit (RLU) values to adjust the assigned master curve. Each calibration solution allows four calibrations to be performed. Refer to the Operator's Manual or LIAISON XL® Quick Guide for calibration instructions.Recalibration is required when* With each new lot of reagents (reagent integral or Starter reagents).
* Every 14 days.
* After servicing the LIAISON XL® Analyzer.
* If quality controls are out of acceptable range.

Calibrator values are stored in the bar codes on the integral label.Comparable results verify the new reagent lot. Discrepant results must be resolved before the reagent can be used for patient testing. |
| **Analytical Measuring Range (AMR)** | EBNA IgG is an FDA-cleared/approved in vitro diagnostic assay that reports the qualitative result based on a predefined cut-off value. Verification of AMR or the cut-off value is not required by CAP or CLIA. DiaSorin stated AMR is 3.00-600.00 U/mL. |
| **Quality Control** | LIAISON® EBNA IgG Serum Control Set ([REF] 310522) are used for monitoring substantial reagent failure of the LIAISON® EBNA IgG chemiluminescent immunoassay (CLIA).* Negative control (0.9 mL x 2 vials) containing a barcode label
* Positive control (0.9 mL x 2 vials) containing a barcode label
* Allow controls to reach room temperature prior to use. Return controls to the refrigerator immediately after each use.

**Frequency:** Run 2 levels with each calibration curve. Load the bar-coded control vials into the “T” rack on the Liaison XL.**Stability:** Unopened: Store at 2-8°C. Stable until the date on vial. Do not use past the expiration date Opened: 8 weeks at 2-8°C between uses. **Acceptable ranges:** * Non-Bio-Rad controls will utilize manufacturer ranges and 2 SD Westgard rules.
* New lots of Bio-Rad controls should be run for 20 days in parallel with the current lot whenever possible prior to switching to the new lot.
* Refer to the [Westgard Rules in Chemistry procedure](https://starnet.childrenshc.org/References/labsop/chem/quality/ch-2.18-westgard-rules-in-chemistry.pdf) for current Westgard rules in place for each analyte.
* **Acceptable ranges are current in Unity Real Time only.** Quality Control results must be rejected in Sunquest when the results cross the interface.
* In the event of a QC failure, refer to the [Unity Real Time QC Review, General User](https://starnet.childrenshc.org/References/labsop/chem/quality/ch-2.17-unity-real-time-qc-review-general-user.pdf) and navigate to the QC Troubleshooting section.
* Do not load or release patients until QC is acceptable in Unity Real Time.
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| **Procedure** | Refer to the instrument Operating procedure.Strict adherence to the Operator's Manual ensures proper assay performance. **LIAISON**® **XL Analyzer**. Each test parameter is identified via information encoded in the reagent integral Radio Fre­quency Identification transponder (RFID Tag). In the event that the RFID Tag cannot be read by the analyzer, the integral cannot be used. Do not discard the reagent integral; contact your local DiaSorin technical support for instruction.The Analyzer operations are as follows:1. Dispense calibrators, controls or specimens into the reaction module.2. Dispense coated magnetic particles.3. Dispense specimen diluent.4. Incubate. 5. Wash with Wash/System liquid.6. Dispense conjugate into the reaction module.7. Incubate. 8. Wash with Wash/System liquid.9. Add the Starter Kit and measure the light emitted.Procedural details for the test may be viewed directly from the Analyzer's assay definition displays. |
| **Interpretation/****Results/Alert Values** | The Analyzer automatically calculates EBV EBNA IgG antibody concentrations expressed as U/mL and grades the results.A **cutoff of 20 U/mL** provides the best balance of sensitivity and specificity. An **equivocal range of 18.0-21.9 U/mL** was applied to the assay to account for normal measurement imprecision.Results between 18.0 – 21.9 U/mL (***equivocal)*** should be repeat tested. If the result is the same after repeat testing, a second sample should be collected and tested no less than one or two weeks later.**Warning** - When a sample result displays the exclamation mark **(!) flag**, the result obtained lies below the assay's signal range. With Software V2.0, the sample should be retested and graded negative if the result is still below the signal range upon retest. With Software V2.2, the sample result is not reported, and the sample must be retested.**Note** - *The magnitude of the measured result*, *above the cutoff, is not indicative of the amount of antibody present*.The accurate distinction of a primary infection from seronegative status or past infection is a key concern of EBV diagnostics. The presence of other EBV serological markers (e.g. VCA IgM, VCA IgG) should be determined to assess the immunological status to infection with EBV. Based on the results of three commonly-used antibody tests (VCA IgG, VCA IgM, EBNA-1 IgG), distinct serological profiles have been described in the medical literature

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| Condition  | VCA IgG | VCA IgM | EBNA-1 IgG |
| EBV seronegative | - | - | - |
| Acute infection | + | + | - |
| Past infection | + | - | + |
| Indeterminate |
| VCA IgG only | + | - | - |
| VCA IgM only | - | + | - |
| EBNA IgG only | - | - | + |
| Convalescent | + | + | + |

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| **Dilutions** | Do not dilute. See result Reporting. |
| **Reference Intervals** | < 18.0 U/mL = Negative Absence of detectable EBNA IgG antibodies. A negative result generally excludes past EBV infection. If exposure to Epstein-Barr virus is suspected despite a negative finding, a second sample should be collected and tested no less than one to two weeks later.18.0 to 21.9 U/mL = Equivocal ≥ 22.0 U/mL = Positive Presence of detectable EBNA IgG antibodies. A positive result is indicative of past infection. |
| Limitations | 1. Do not heat-inactivate sera.
2. The clinical diagnosis must be interpreted with clinical signs and symptoms of the patient. The results from this kit are not by themselves diagnostic and should be considered in association with other clinical data and patient symptoms.
3. Results from immunosuppressed patients should be interpreted with caution.Assay performance characteristics have not been established for immunocompromised or immunosuppressed patients, cord blood, neonatal specimens, or infants.
4. Diseases such as cytomegalovirus, toxoplasmosis and hepatitis may cause symptoms similar to infectious mononucleosis and must be excluded before confirmation of diagnosis.
5. The combined use of EBV serological markers and clinical data is recommended when the diagnosis of EBV infection is based on a single serum specimen. A single result cannot be used for diagnosis. Accurate interpretation of EBV infection is based on results of EA(D) IgG, VCA IgM, VCA IgG, EBNA IgG, EBNA IgM and heterophile antibodies.
6. The performance characteristics have not been established for patients with nasopharyngeal carcinoma, Burkitt's lymphoma, EBV-associated lymphadenopathies and other EBV-associated diseases besides EBV-related mononucleosis.
7. Assay performance characteristics have not been established for the diagnosis of nasopharyngeal carcinoma, Burkitt's lymphoma, and other EBV-associated lymphomas.
8. Assay interference due to circulating antibodies against HIV and Hepatitis A, Hepatitis B and Hepatitis C viruses has not been evaluated. The user is responsible for establishing cross-reactivity performance with these infectious agents.

**Interferences:** assay performance was not affected by * Hemolysis (at 1000 mg/dL hemoglobin)
* Lipemia (at 3000 mg/dL triglycerides)
* Icterus (at 10 mg/dL bilirubin).
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| **Result Reporting** | Review, validate, and tag results and send to Sunquest. Release results in Sunquest following LIS procedures for OEM. Comments are automatically appended when resulting in OEM or MEM using the LIAS worksheet.* Results <18.0 U/mL without error messages are reported with the numerical result, and interpreted as Negative. Append the comment “A negative result generally excludes past EBV infection”
* Results between 18.0 – 21.9 U/mL must be repeated prior to reporting and are reported with the numerical result, and interpreted as Equivocal. Append the comment “a second sample should be collected and tested in one or two weeks”
* Results > 21.9 U/mL without error messages are reported with the numerical result, and interpreted as Positive. Append the comment “Presence of detectable EBNA IgG antibodies. A positive result is indicative of past infection.”
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| **Alternate Methods** | * When test performance does not meet quality standards, consult the technical specialist or Medical Director, and refer testing to Mayo Medical Laboratory.
* Order test 84421, Epstein Barr virus Antibody Profile, and submit 1.0 mL of serum, 0.6 mL minimum for all three EBV profile tests.
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| **References** | 1. LIAISON® EBNA IgG (310520) Directions for Use, 10/2012, DiaSorin, Inc, Stillwater, MN 55082. January 2018
2. LIAISON® EBNA IgG Control Directions for Use (310522), EBNA-G-us.fm, 200/007-863, C – 01/2018
3. EBV and CMV in Childhood Diseases, Sam Dunmire Presentation, Hogquist Lab, April 2011
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| **Appendices** | Refer to LIAISON® EBNA IgG (310520) Directions for Use for specific performance characteristics |

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| **Historical Record** | **Version** | **Written/Revised by:** | **Effective Date:** | **Summary of Revisions** |
|  | Linda Lichty | August 15, 2011 | Initial Version |
|  | Linda Lichty | August 22, 2011 | Added statements for clarification of reporting, and QC handling |
|  | Linda Lichty | April 22, 2013 | Update package insert |
|  | Linda Lichty | October 21, 2016 | Revised Sample stability |
|  | Stephen Gripentrog/ K. Brown/ Erin Bartos | August 13, 2019 | Updated procedure to DiaSorin Liaison XL from DiaSorin Liaison. Updated QC reporting for Unity Real Time. |
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